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Fabia Franco and Stanislava Angelova

Middlesex University

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Corresponding author:
Fabia Franco (PhD)
Department of Psychology
School of Science and Technology
Middlesex University
The Burroughs, Hendon
London NW4 4BT
UK
E-MAIL: f.franco@mdx.ac.uk

Co-author:
Stanislava Angelova
CEEDR
Business School
Middlesex University
The Burroughs, Hendon
London NW4 4BT
UK
E-MAIL: s.d.angelova@mdx.ac.uk

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Abstract

This study investigated person perception in respect of variables associated with affect in music (tempo and mode) following motor synchronization to music. Participants (n=128, 50% female) were tested in a task involving stepping with a researcher to the beat of slow or fast music in major or minor mode, following which measures concerning the synchronised partner were collected (incidental memory, likeability of, similarity to and prosocial attitude towards). Significant effects were found only for the 'likeability' measure, modulated by gender, suggesting that variables associated with affect perception in music, such as mode and tempo appear relevant for person perception in a synchronization task in ways that differ for men and women. The results of this 'proof of concept' study indicate the need for further research on the effect of motor synchronization based on ecologically valid musical interaction tasks.

Keywords:

person perception, motor synchronization, music & emotion

Music is as ubiquitous as language in humans (Cross, 2001; Peretz, 2006). Similarly to language, it is a complex domain that involves systematic rhythmically organised sequences of syntactically ordered elements within different cultural traditions. However, differently from language, music is referentially opaque but uniquely organised around an external regular pulse, so affording entrainment to the beat and interpersonal synchronization (Cross & Woodruff, 2009; see also Clayton, 2009). Keeping together in time (e.g., dance, drill) has been described as crucial in human social evolution (McNeil, 1995). As stressed by Merker, Madison and Eckerdal (2009), such spontaneous interpersonal alignment to a musical beat, as observed in dancing and singing, although culturally universal in our species, is biologically rather exceptional: for instance, our closer relatives among the apes do not show any pulse-based entrainment but some vocal species and insects do (see also Schachner, 2010, and Takahashi, Narayanan & Ghazanfar, 2013, for a discussion of evolutionary aspects). Beyond a strong link between perception and action, synchronization has been associated also with the need to anticipate others' behaviours (Lakin, Jefferis, Cheng & Chartrand, 2003) in a variety of rhythmically organised phenomena, which occur intentionally or unintentionally in everyday life (Lakens & Stel, 2011).

Recent studies showed enhanced cognitive performance, increased liking, similarity and pro-social measures in participants synchronising simple motor behaviours to a metronome beat with a social partner (e.g., Hove & Risen, 2009; Macrae, Duffy, Miles and Lawrence, 2008; Valdesolo & DeSteno, 2011; for developmental studies, see Cirelli, Einarson & Trainor, 2014; Kirschner & Tomasello, 2010; Rabinowitch, Cross & Burnard, 2012). Moreover, observers attribute increased rapport and entiativity to synchronised partners, particularly when this occurs spontaneously (Lakens and Stel, 2011). In order to generalise the findings from studies using a metronome to generate an external, regular beat for participants to entrain their motor behaviours, it is critical to test the same tasks using the signal that in human communication has specialised for this purpose: music.

However, rhythm and tempo are not emotionally neutral aspects of a musical experience. The complexity of music has been broken down into

separate variables in order to study how emotional qualities are conveyed to listeners (Gabrielsson & Lindström, 2010; Juslin & Västfjäll, 2008; Juslin & Timmers, 2010; Sloboda & O'Neil, 2001), yielding patterns associating positive emotions (e.g., happiness) with fast tempo / major mode, whereas sadness tends to be associated with slow tempo / minor mode (Dalla Bella, Peretz, Rousseau and Gosselin, 2001; Huron & Davis, 2013, among others).

Attempting a more ecologically valid framework, we aim to extend the study of person perception to a motor synchronization task using musical rather than metronomic stimuli, and analysing the results in respect of variables associated with affect in music (tempo and mode). If synchronisation facilitates the extension of affect from the music embodying it to the synchronised partner, the following effects may be hypothesised: [i] higher likeability and similarity ratings with music associated with 'happy' affect compared to 'sad' affect, [ii] no difference in pro-social ratings since altruism in economic games was not increased with 'joyful' singing compared with other synchronisation conditions in other studies (Wiltermuth & Heath, 2009), [iii] lower likeability and similarity ratings with 'sad' music due to its negative association, [iv] possibly increased pro-social responses towards a partner embodying sad affect (hence need of support) via synchronisation to 'sad' music, [v] independently from mode, fast tempi would facilitate incidental memory, if a direct effect of arousal is involved (Macrae et al., 2008; see also Large & Jones, 1999, for enhanced attentional resourced in synchronised conditions). Control conditions will separate mode/tempo effects with the inclusion of music in major mode/slow tempo and minor mode/fast tempo. Gender effects are not predicted in the musical conditions associated with primary emotions ('happy'/'sad').

Method

Participants

University students (n = 128) were randomly allocated to four independent music conditions (each n = 32, 50% female) as in 'Stimuli and Measures'.

Design

The experiment used a 2x2x2 independent group design with slow (84 BPM) / fast (127 BPM) tempo, major / minor mode, and gender. Four dependent variables were examined: incidental memory (number of words recalled from a list of 20) concerning the synchronised partner (SP henceforth), likability of and similarity with the SP, and pro-social behaviour (willingness to help the SP in another time consuming experiment). These variables and a final question on how 'interesting' participants found the experience were measured on 7-point Likert scales (1=not at all, 7=very much; see Valdesolo and DeSteno, 2011).

Stimuli and Measures

Stimuli N 1(2)-4(3) from the dataset created by B. Bouchard for Peretz, Gagnon and Bouchard (1998) were used. An original excerpt (Vivaldi, 'L'Autunno', 1st mvt) transcribed for piano and computer generated was electronically manipulated and developed into four variants adjusted for mode and tempo to create four conditions: 1) fast tempo and major mode [original - major/fast henceforth], 2) fast tempo with minor mode (minor/fast henceforth), 3) slow tempo with major mode (major/slow henceforth) and 4) slow tempo with minor mode (minor/slow henceforth). For the present study, the original excerpt with four bars was looped to match the duration of 60 sec in Macrae et al. (2008), with a 1.09-minute soundtrack for each condition. In order to support synchronization in a dance-like task, it was necessary to regularise the rhythmic pattern. While the first three bars remained unchanged, the fourth bar was adjusted with a simple repetition of the last note to replace silent beats. Test samples were also created for practice trials (18s-duration).

Similarly to Macrae et al. (2008), an incidental memory task involved 20 carefully selected commonly used monosyllables with similar phonetic complexity. The selected words (cold, shirt, walk, step, desk, stick, smile, spoon, milk, talk, book, watch, shoe, nose, tree, glass, horse, bush, door) belonged to the same classification, with estimated means for the word frequency count and the number of phonemes in the words being 88.9 and 3.4, respectively (MRC Psycholinguistic Database; Wilson & Quinlan, 1987).

In a thirteen-item questionnaire there were four critical questions on the dependent variables, with the remaining questions as distracters. Due to the limited resources available for this study, rather than the complex altruistic task

used in Valdesolo and DeSteno (2011) participants were asked a pro-social question: "*If the researcher were running another, time-consuming study, how willing would you be to help her*". In a similar way likability and sense of similarity were assessed with the questions "*Was the researcher nice and competent*"[1] and "*To what extent do you feel like-minded with the researcher you completed the task with*", respectively.

Procedure

Once invited individually into a laboratory, participants were informed that the study aimed to investigate the influence of musical experiences on person perception. They were explained that the researcher would wear a neutral facemask in order to minimise any unintentional facial signals (Figure 1). They were also informed that, while performing the 'stepping task' with the participants, the researcher might produce some common words. Participants were asked to concentrate on synchronising with the musical beat rather than on the researcher, and were not informed that they will be asked to recall these words.

In order to familiarise with the task, participants were first exposed to a test trial of the relevant musical stimuli, and shown what to do in the synchronisation task with the researcher, which involved side steps to the music beat. With the participants positioned facing the researcher 1 meter away, the synchronisation task consisted of stepping, from a central position with the two feet together, with the left foot to the left of the midline, followed by moving the right foot next to it, then going back to the initial position and subsequently moving the right foot to the right of the midline and stepping with left foot next to it, and so on. This task was used as a proxy for dancing or marching, which during piloting appeared more 'embarrassing' for participants. Soundtracks were delivered via a MacBook Pro laptop with external speakers. The researcher used a reminder list of the words for the incidental memory variable (as in Macrae et al., 2008), attached to a screen positioned behind the participant.

[1] As only one female experimenter was available for this study, this question was preferred to "*How much did you like the researcher*?" in order to limit possible interferences due to attractiveness/personal preferences.

Figure 1.

Researcher wearing a neutral facemask during the task.

Synchronisation between the participant and the researcher occurred as they were moving to the same beat, with the attention of the participant being explicitly directed to the music rather than to the researcher (Hove and Risen, 2009). Differently from the participant, the researcher was instructed to focus on her partner (the participant). In order to help synchronisation to get established first, the researcher began producing words only after the first bar of the musical stimuli. From that point, the words were produced on the beat approximately every 3 seconds (i.e., every 8 steps in the fast tempo and every 6 steps in the slow tempo).

Subsequently, participants were asked to write down the words pronounced by the researcher during the synchronisation task (incidental memory recall, 5 min). Then the experimenter left the room after instructing the participants to fill-in the questionnaire and then place both list with recalled words and questionnaire in an envelope, to be dropped in a ballot box.

Results

Four three-way independent-groups ANOVAs were carried out to assess the effects of mode, tempo and gender on each dependent measure.

Non-significant results were found for incidental memory (word recall), 'similarity' and 'pro-social' variables. Some trends may be noted (Table 1): both men and women perceived lower levels of similarity with the SP in the minor/slow condition (sad affect) and in the minor/fast condition (men only), than in other conditions. A marginal tendency to recall more words with fast tempi can be noted, and high levels of pro-social commitment to the SP were observed across conditions.

Table 1.

Mean (SD) scores for incidental memory concerning the synchronized partner (n words), perceived similarity with synchronized partner and pro-social commitment to synchronized partner (1-7 Likert scales).

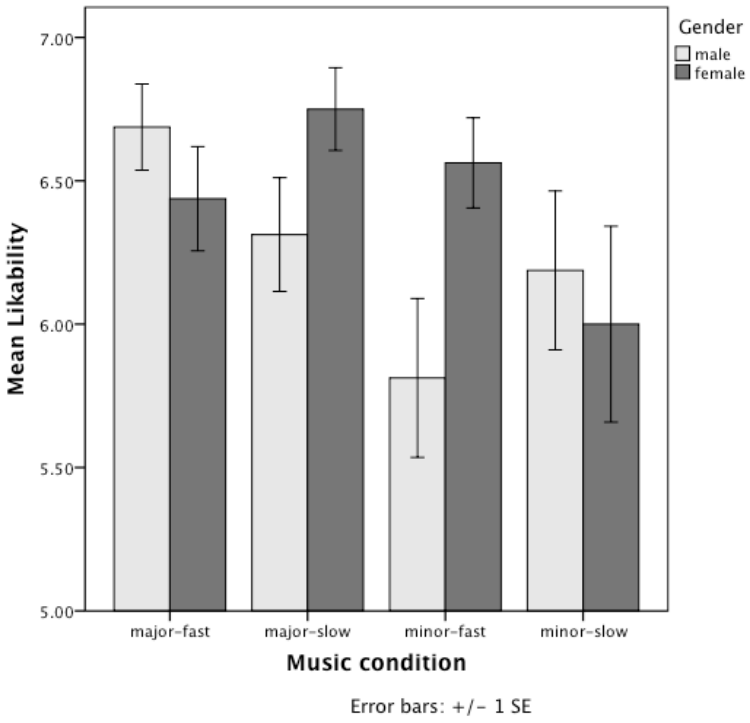
Condition		Incidental memory		Similarity with synchronized partner		Pro-social commitment to synchronized partner	
Mode	Tempo	Men	Women	Men	Women	Men	Women
Major mode	Fast tempo	4.81 (2.10)	5.00 (1.79)	5.00 (1.37)	5.56 (1.15)	6.44 (0.73)	6.62 (0.62)
	Slow tempo	4.31 (2.98)	5.00 (2.91)	5.31 (1.25)	5.56 (1.09)	6.62 (0.62)	6.37 (1.09)
Minor mode	Fast tempo	4.00 (1.90)	5.00 (2.25)	4.81 (1.22)	5.60 (1.26)	6.12 (1.02)	6.44 (1.09)
	Slow tempo	4.00 (2.28)	4.06 (2.05)	4.94 (1.29)	4.75 (1.57)	6.44 (0.96)	6.44 (0.73)

'Likeability' of the SP was associated with significant effects, namely a main effect of mode, $F(1,120) = 6.5$, $p = .012$, $\eta_p^2 = .05$, revealing higher ratings when synchronizing with music in the major mode ($M = 6.6$, $SE = .113$) than in

the minor mode (M = 6.1, SE = .113). Gender differences appeared in the two groups synchronizing with major/slow and minor/fast music, as indicated by a small but significant effect of the gender x mode x tempo interaction, $F(1,120) = 7.5$, $p = .007$, $\eta_p^2 = .06$ (Figure 2). As predicted, both men and women scored the likeability of the SP higher with major/fast music (happy affect) than with minor/slow music (sad affect) ($p = .04$), with the difference between the two gender groups being NS in these two conditions. However, women presented higher likeability scores for the SP than men in both conditions with major/slow music ($p = .086$) and particularly with minor/fast music ($p = .025$).

Figure 2.

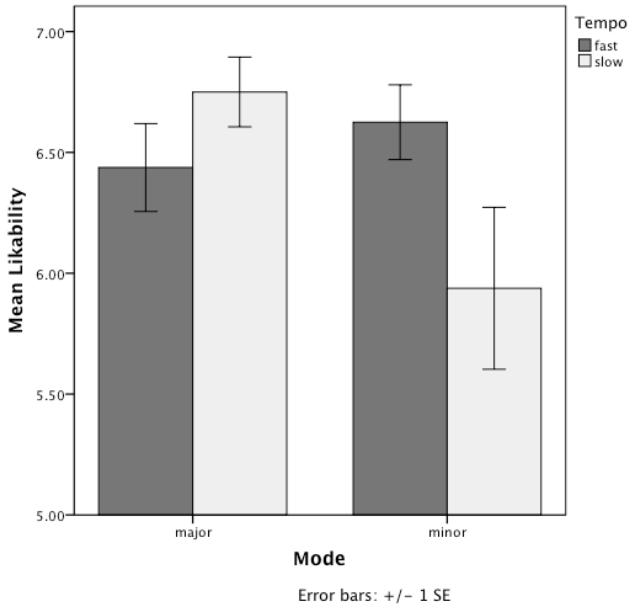
Scoring of the synchronized partner on the 'Likability' question in the four independent mode/tempo conditions by participants' gender. Error bars are standard errors of the mean.



Follow-up analyses by gender yielded a significant mode x tempo interaction for women ($F(1,60) = 5.26$, $p = .025$, , $\eta_p^2 = .08$), who liked the researcher most with major/slow or minor/fast music and least with minor/slow (Figure 3).

Figure 3.

Female participants' ratings of the synchronized partner on the 'Likability' scale (1-7) in the four independent mode/tempo conditions. Error bars are standard errors of the mean.



Men presented only the main effect of mode ($F(1,60) = 4.64$, $p = .035$, $\eta_p^2 = .07$), as they rated the SP more likeable overall while synchronizing with music in the major mode ($M = 6.50$, $SE = 0.164$) than in the minor mode ($M = 6.00$, $SE = 0.164$). Men also found the experience more "interesting" with slow ($M = 5.88$, $SE = 0.216$) than fast tempo ($M = 5.22$, $SE = 0.216$), $F(1,60) = 4.62$, $p = .036$, $\eta_p^2 = .07$.

Discussion

We consider the present study a 'proof of concept' contributing to the devising of an appropriate paradigm in synchronization tasks aimed to investigate affect variables associated with musical expressive cues, supporting the use of a more naturalistic musical dimension to the field. Although an isochronous, external pulse affording entrainment of motor behaviour and inter-individual synchronization may be considered a specialization of music (Cross et al., 2013;

Cross & Woodruff, 2009), most studies of the effects of synchronization on cognitive or social behaviour are based instead on metronome beat, with few exceptions. For instance, besides Woolhouse & Tidhar (2010) described above, Wiltermuth & Heath (2009) asked participants to perform a variety of tasks (to walk in step together; to sing or to sing and move synchronously) and found that they were more cooperative in subsequent economic games, compared with participants that did not have the opportunity to synchronize, even when positive emotion was not intrinsic to the synchronising exercise.

Broadly speaking, the original hypotheses were at least in part consistent with the results. Although modulated by gender, significant effects were found on perceived 'likeability' of the SP in function of the musical dimensions of mode and tempo. This suggests that the emotional qualities of the music extended to the interaction with the SP. In particular, likeability of the SP was rated higher when stepping together to music in the major mode, consistently with findings that mode predicts perceived valence in music, namely major mode/positive valence (e.g., Costa, Fine and Ricci-Bitti, 2004). There was a tendency to find the SP more likeable with 'happy' affect (major/fast) than 'sad' affect (minor/slow), although for men the lowest ratings of the SP were with minor/fast music (which in some contexts might be interpreted as expressing 'anger' or tension - for a review, Gabrielsson & Lindström, 2010).

The classification of musical emotion (expressed, induced, perceived etc.) on the basis of two general dimensions such as mode and tempo is a statistical simplification of a much richer and differentiated set of parameters that could capture emotional variables or have a bearing on affect perceived in music (e.g., harmonic intervals and frequency ratios, loudness, texture, timber, dynamics, articulation - Eerola, Friberg & Bresin, 2013; Juslin & Lindström, 2010), and as such cannot be considered exhaustive. Nonetheless, the results of the present study are novel in proposing specific emotional influences on social perception dimensions as a result of interpersonal synchronization mediated by music.

Expected results concerning incidental memory, similarity to, and pro-social behaviours towards the SP were not replicated. Differently from previous studies, there were no parallel conditions with no-synchronization because the present experiment aimed to address novel dimensions (rather than reproduce the synchrony/no-synchrony effects). It may be that, as far as there is inter-

individual synchronization (as opposed to lack of synchrony), incidental memory, perceived similarity and pro-social behaviour will be enhanced, irrespective of musical affect dimensions. This needs to be tested empirically in future studies using music with different emotional characteristics in synchrony vs. no-synchrony interactional conditions, but in support of this possibility the results of Woolhouse and Tidhar (2010) indeed showed that in a silent-disco context, incidental memory for a dancing partner's features was superior in pairs dancing in-tempo to the same music track than in pairs dancing unknowingly to manipulated tracks with different tempi (see Lakens & Stel, 2011, for non-significant results of synchronisation on perceived similarity by observers).

The finding that incidental memory did not vary with fast/slow tempi suggests that synchronization per se, rather than arousal, was the factor that in other studies caused improved recall in the synchronization groups. However, the music in the present experiment was not particularly 'groovy' and unlikely to have corresponded to many participants' (university students) preferences. Therefore, tempo variations may have produced a more diluted effect on arousal compared to using proper dance music. There was some indication that tempo differences (independently from mode) were noticed, e.g., men judged the experience more 'interesting' with slow tempi, possibly due to higher attention demands perceived in this condition.

Perceived similarity with the SP received the lowest ratings. The lack of significant effects of the musical aspects on this variable may be, at least in part, a consequence of the environment in which data collection occurred, i.e. multi-ethnic and multi-cultural, with high levels of heterogeneity also in respect of musical cultures. Concerning pro-social attitudes and behaviours, our task was simplified in comparison to Valdesolo & DeSteno (2011) and moved the focus from behaviour to attitude – this may have changed the task requirements, hindering replicability of this effect. Alternatively, as for incidental memory, it is possible that synchronization per se is at the origin of the effect described by Valdesolo & DeSteno (2011), musical affect variables playing little part. Behavioural tasks with both explicit and implicit measures should be used in future research in order to provide more reliable indicators of altruism and empathy.

The results in some measures may have been influenced by near-ceiling effects in this study. This might be due to the musical dimension (e.g., more pleasant than the metronome experience used in other studies, leading to more participants liking the SP 'very much'). Crucially, future studies will need to measure synchronization objectively; in the present study synchronization was assumed to have occurred as both partners were moving to the same beat (Hove & Risen, 2009) and the researcher was focusing on the participant exposing herself to the possibility of entraining, to a certain extent, with the participants (rather than just to the musical beat). However, a few participants had to be discarded because clearly self-synchronising (i.e., moving to a preferred beat rather than the music beat). Spontaneous motor tempo baseline and objective entrainment measures would allow us to co-vary synchronization coefficients with the person perception measures.

Considering the gender effect found in the present study, it is possible that an uncontrolled interaction between participant's and experimenter's gender occurred, influencing the results. In future research in this field, involving real interactions, it would be desirable to include controls over variables such as same- vs. opposite-gender pairings, ideally with a screening of participants' sexual orientation.

The mode/tempo interaction on the perceived likeability of the SP was modulated by gender. Women's likeability scores were highest with major/slow and minor/fast music whereas men scored the researcher's likeability higher with music in the major mode in general, and lowest with minor/fast. This interaction was unexpected since gender effects have not been controlled in synchronization studies. Our results suggest caution in generalising findings from such studies; for instance, in Macrae et al. (2008) more than 80% participants were female hence, in the light of our results, their findings do not necessarily extend to men.

Why might women present more nuanced effects? The literature reports that women show more differentiated responses to music (Juslin & Sloboda, 2011 for a review), are more sensitive to intermediate qualities on a happy/sad continuum based on mode, tempo and texture (Webster & Weir, 2005), and present more symmetrical brain processing of music than men from childhood (Koelsch, Maess, Grossmann & Friederici, 2003; Koelsch, Grossmann, Gunter,

Hahne, Schroger & Friederici, 2003). Furthermore, musical expertise-related anatomy changes are found in men but not women (corpus callosum, Lee, Chen & Schlaung, 2003). When considering motor responses, women respond equally well to a variety of musical types when synchronizing exercise, whereas men perform better with a metronome (Karageorghis, Priest, Williams, Hirani, Lannon & Bates, 2010). Finally, arousal regulation and pain reduction associated with music are found in female but not male patients (Kenntner-Mabiala, Gorges, Alpers, Lehmann & Pauli, 2007). Thus, significant if subtle gender differences are found, providing ground to consider further the gender effects.

Since gender effects are not reported in most literature on synchronization, the gender of the researcher (SP) was not factored into the design of this study. A possibility that future research must explore is that gender effects emerged here as a results of one gender stepping with a same-gender SP and the other with the other-gender SP: we cannot exclude at this stage that person perception results might reverse or change if the SP were male. At a theoretical level, one may speculate on evolutionary implications possibly underlying gender differences in this context. Male participants were sensitive to an association major mode/high likeability of SP, particularly when associated with fast tempo hence increased arousal. Extending to group contexts, this might be consistent with positive in-group emotion (e.g., anthems, military drill; Kroeger, 2000) and cooperative preparedness for action. The lowest likeability of SP with minor/fast music may be associated with perceiving 'anger-like' affect (more tension) in this musical stimulus, experiencing an aversive reaction to engaging in interactions perceived as potentially more aggressive.

Female participants appeared sensitive to the less obviously prototypical expressive cue/emotion perception associations, that is, those that may be considered as presenting a higher degree of ambiguity/alternative interpretations (Zentner, Grandjean & Scherer, 2008) hence requiring more sensitive readings based on contextual features (major/slow and minor/fast). In addition to the more nuanced music-user profile reported in the above literature, women's ancestral background is deeply rooted in species-specific behaviours such as infant-directed speech and music more broadly associated

with caring experiences (Cross et al., 2013; Falk, 2004; Lewis, 2009, 2013; Trehub, Becker & Morley, 2015). Cross and Woodruff (2009) elucidate such contexts as characteristic of the core function of music from an evolutionary point of view, that is, negotiating situations of uncertainty by resolving ambiguity through musical interaction.

The naturalistic ambition of the present study was limited by the use of [i] unfamiliar music rather than population-appropriate dance music and [ii] a mask concealing the SP's face. In both cases the choice was determined by the intention to control confounding factors, given the novelty of the paradigm. As our focus was on the potential influence of music expressive cues, we considered more important in the first instance to experimentally control the music variables in order to eliminate inevitable confoundings associated with 'real' music in which several variables may change across different pieces, besides those manipulated in the experiment (mode and tempo here). A second problem addressed by our choices was participants' individual preferences and different cultural backgrounds and familiarity with dance music/s, given the wide cultural differences present in the population from which the participant sample was taken. By choosing a relatively abstract and mostly unfamiliar genre within the population, we deemed to minimize the potential uneven interference of the above factors. Concerning the mask, the SP's facial emotion would have presented considerable uncontrolled threats to the validity of an experiment aiming to study the effect of emotional cues associated with music and synchronized movement.

Having established a baseline for this paradigm within the present study, future research may be developed further separating the effects of synchronizing to emotionally different music from simple exposure to emotionally different music on the social variables included in the present study, which would clarify how crucial is the role of movement. In this perspective, the potential role played by the interaction between a participant's mood and the musical emotion would be another critical aspect to carefully control (Franco et al., 2014).

Despite the limitations discussed above, this 'proof of concept' study was successful in showing specific influences of music emotional qualities on inter-

personal perception of synchronizing partners. Together with previous findings, this identifies an important area of research the development of which depends on interdisciplinary collaboration.

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